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CALSPAN ON-SITE AMBULANCE CRASH INVESTIGATION

SCI CASE NO.: CA11027

VEHICLE: 2009 CHEVROLET G4500 CHASSIS / AEV TYPE III AMBULANCE

LOCATION: SOUTH CAROLINA

CRASH DATE: OCTOBER 2011

Contract No. DTNH22-07-C-00043

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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TABLE OF CONTENTS

CALSPAN ON-SITE AMBULANCE CRASH INVESTIGATION
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BACKGROUND

This on-site investigation focused on the rollover crash of a 2009 Chevrolet G4500 series chassis with an AEV Type III ambulance body (**Figure 1**). The Calspan Special Crash Investigations (SCI) team identified the crash through internet media reports on October 12, 2011. The Crash Investigation Division (CID) of the National Highway Traffic Safety Administration (NHTSA) directed the Calspan SCI team to initiate telephone follow-up on the same day. Initial contact with the local law enforcement provided information regarding the return of the ambulance to the parent ambulance agency. The SCI Investigator established cooperation with the Operations Manager of the ambulance agency to inspect the vehicle on October 18, 2011, and the on-site portion of the investigation was scheduled to take place October 26-27, 2011. Unforeseen legal implications arose unexpectedly and the SCI Investigator had to establish cooperation with both parties' attorneys, which was achieved on November 1, 2001. Subsequently, the on-site portion of this investigation had to be re-scheduled, and ultimately took place November 3-4, 2011. This consisted of the detailed inspection and documentation of the ambulance and crash site, with interviews of the ambulance agency's administration and the Emergency Medical Services (EMS) crewmembers involved. Also, the Event Data Recorder (EDR) of the Chevrolet ambulance was imaged.

Figure 1: Involved ambulance at final rest *(image from a local news source).*

The ambulance was traveling westbound on a four-lane roadway, occupied by a 29-year-old male driver, a 21-year-old female EMS crewmember, and the 79-year-old female patient who was being transported to a local hospital for an unknown medical problem. The ambulance departed the right roadway edge, and the driver provided left steering input in an attempt to regain the travel lanes. This avoidance action was unsuccessful as the ambulance traversed back across the westbound lanes and entered the median, where the vehicle then initiated a rollover sequence and completed five-quarter turns. The crash resulted in the death of the 79-year-old female patient, who sustained severe traumatic injuries. The driver was transported to a local hospital, where he was treated and released. The EMS crewmember was transported to a local hospital, then transferred to a regional trauma center where she was admitted for treatment.

SUMMARY

Crash Site

Figure 2: Westbound trajectory view of the ambulance's travel path.

The crash occurred on a multi-lane, divided roadway during nighttime hours. Weather conditions at the time of the crash were heavy rain with a temperature of 20 Celsius (68 Fahrenheit) degrees, 16.7 km/h (10.4 mph) east-northeasterly breeze, and 94% relative humidity. The roadway surfaces were wet bituminous (asphalt) for both the eastbound and westbound portions of the roadway. The westbound portion consisted of two 3.7 m (12 ft) wide travel lanes delineated by a single-dashed white line. A single-solid yellow line separated the left lane from the 11 m (36 ft) wide depressed grass median, while a single-solid white line separated the right lane from a grass roadside swale area. For the ambulance's westbound direction of travel, the straight and level roadway transitioned into a left-hand curve with radius of curvature of 300 m (984 ft) (**Figure 2**). Speed was regulated by a posted limit of 89 km/h (55 mph). A Crash Diagram is included on page 25 of this technical report.

Pre-Crash

A local emergency response system received an emergent call regarding a 79-year-old female who was experiencing respiratory distress. Subsequently, the parent ambulance agency was dispatched to answer the request. The ambulance agency responded by sending an available Basic Life Support (BLS) ambulance to the scene, staffed by the 29-year-old male driver and 21-year-old female Paramedic. Both crewmembers had begun their shifts an unknown exact number of hours earlier, and had already responded to at least one prior EMS request together.

The ambulance arrived at the location of the request and was presented with the 79-year-old female patient who was experiencing difficulty in breathing. The patient had a history of medical ailments including renal failure, for which she received regular dialysis via a shunt in her left arm three times per week. Furthermore, her prior health conditions included the bilateral amputation of her lower extremities at the knees. Due to her health history, the patient's family was requesting ambulance transport to a local hospital for evaluation and treatment. After the Paramedic performed a brief physical exam, the two crewmembers moved the patient onto the stretcher and placed her in an anatomical position of comfort. They then utilized the multi-point harness system to manually restrain the patient to the stretcher, after which they loaded the stretcher into the patient compartment module of the ambulance and secured it in place.

The stretcher was secured within the longitudinal center area of the patient compartment module via a locking pin/clamp mechanism that was anchored to the floor. The Paramedic seated herself on the bench seat in order to interact with and care for the patient, while the driver positioned himself within the driver's seat of the cab. Subsequently, the driver began to operate the ambulance in a non-emergency mode (without use of emergency warning lights or siren) toward the local hospital.

The Paramedic assessed the patient's vital signs, obtaining the patient's blood pressure, heart rate, respiratory rate, and circulatory response. After completing her assessment of the patient, the Paramedic moved from the bench seat and assumed an upright seating position within the "Captain's Chair". Meanwhile, the driver was operating the ambulance in the right travel lane of the westbound portion of the roadway.

The ambulance remained on its westbound trajectory within the right travel lane for an unspecified distance. Pre-crash data imaged from the vehicle's EDR reported that the vehicle's speed 2.5 seconds prior to algorithm enable (AE) was 121 km/h (75 mph). For reasons unknown, the ambulance's right side tires departed the north roadway edge at the onset of a slight left-hand curve. The driver recognized the right roadside departure as the vehicle maintained its forward trajectory and provided left steering input in an attempt to regain the travel lanes, as the left side tires also departed the right roadway edge. This left steering input enabled the vehicle to maintain the curvature of the roadside swale area as the vehicle continued on its westbound trajectory. Due to the vehicle's speed and the reduced frictional coefficient of the soil/grass surface from the heavy rainfall, the sharp left steering input instigated a counterclockwise (CCW) rotation. Accordingly, the ambulance achieved a right-side leading orientation as it entered a CCW yaw.

Figure 3: West-facing view of yawing tire marks through roadside swale.

The vehicle maintained a westbound trajectory as it continued its CCW yaw. Due to the sharper curvature of the yaw with respect to the angle of curvature of the roadway, the left front tire reentered the roadway. The point of reentry for the left front tire was located at a distance 62 m (203.5 ft) west of its point of initial departure. Subsequently, the right rear tires reentered the roadway as the vehicle approached 90 degrees of total rotation. The point of reentry for the right rear tires was 120 m (394 ft) west of their initial roadside departure location. The vehicle traversed southwest across both travel lanes as it surpassed 90 degrees of rotation. Tire marks through the roadside swale area and on the asphalt roadway surface evidenced the vehicle's travel path (**Figure 3**).

Crash

The right side-leading orientation created an instability with respect to the vehicle's longitudinal central axis of gravity due to the increasing drag force load on the right side tires. These forces depressed the sidewall of the outside right rear tire, which rolled the bead off of the wheel rim and deflated the tire. Subsequently, the outward edge of the wheel contacted the asphalt roadway surface. This contact resulted in abrasions to the wheel rim and a metallic gouge in the roadway surface, located approximately 135 m (443 ft) west of the initial right rear roadside departure. These dynamics instigated a trip-over into a right side-leading rollover (Event 1).

The vehicle maintained forward movement as it began the first-quarter turn of the rollover sequence. The front plane entered the depressed grass median, and the right aspect of the vehicle's front bumper contacted the ground. As the vehicle achieved 90 degrees of longitudinal rotation, the forward upper aspect of the right exterior of the patient compartment module contacted the ground within the center of the depressed grass median. This contact resulted in a 1.5 m (5 ft) wide gouge in the soil surface, located 145 m (476 ft) west of the initial roadside departure point. The ambulance maintained its trajectory and continued its rollover sequence uninterrupted. As it completed its third-quarter turn, contact with the ground resulted in two more gouges in the soil surface of the median. These gouges were located 158 m (518 ft) and 163 m (535 ft), respectively, west of the initial right roadside departure.

The ambulance's uninterrupted rollover sequence was completed with a minimum of five -quarter turns. During the duration of the rollover sequence, medical supplies, equipment bags, and cabinetry became dislodged from their secured and/or unsecured positions and were subsequently displaced throughout the interior of the patient compartment module. The ambulance came to final rest on its right side, facing south, with the cab straddling the south edge of the eastbound portion of the roadway and the patient compartment module blocking the eastbound portion's right lane. **Figure 4** depicts a lookback view from final rest of the ambulance's rollover path.

Figure 4: Eastward lookback view from final rest to the rollover path.

Post-Crash

At rest, the mobile radio's microphone dangled precariously from the left wall in front of the Paramedic's face. She retrieved this microphone and called for help from the local emergency response system. The parent ambulance agency responded by dispatching local law enforcement and fire department personnel, as well as multiple agency ambulances and administrative personnel.

One of the ambulance agency's Field Supervisors, who was going off-duty for the evening, was arriving at his home. He overheard the radio traffic regarding the crash, which coincidently occurred less than 1 km (0.5 mi) from his residence. He advised the communications center of his proximity to the crash and immediately responded directly to the scene.

An off-duty medical doctor was traveling home after completing his shift at the local hospital. Coincident to the involved ambulance and its activities, the doctor was traveling eastbound on the same divided roadway and witnessed the crash from a distance as he approached its location. Subsequently, he stopped and rushed to the overturned ambulance in an effort to assist and attend to the occupants. He opened the rear doors of the patient compartment module and began to verbally communicate with the EMS crew as the Field Supervisor arrived on location. The Field Supervisor joined the doctor, and the pair located the female Paramedic and patient within the forward area of the patient compartment module by the right occupant access door. Both were covered by patient compartment module components and various equipment, including separated cabinetry, separated ceiling panels, displaced medical supplies, displaced equipment bags, the electrocardiograph (ECG) monitor/defibrillator unit, and the displaced stretcher. The Field Supervisor and doctor immediately began removing the debris in an effort to disentangle the Paramedic and patient.

While the Field Supervisor and doctor were engaged in their efforts in the patient compartment module, the driver was attempting egress from the vehicle's cab. His body was out of position within the safety belt webbing and he was partially suspended, a result of the non-horizontal and centrifugal forces associated with the rollover. It remains unknown if the driver unbuckled his belt or slid out of the webbing. In either case, he subsequently stepped on the left side of the center console and opened the left front door, climbed up and out of the cab, and jumped down to the ground. He then moved to assist the Field Supervisor and passerby doctor. As emergency response personnel arrived, the driver was soon relieved of his activities to receive emergency medical care. He was transported via ground ambulance to a local hospital, where he was treated and released within a 24-hour period.

Emergency response personnel removed the displaced/separated debris from the patient compartment module and located the patient and Paramedic. The patient was still in a restrained position on the stretcher, but did not have a palpable carotid pulse. Attention was refocused on removal of the female Paramedic. A cervical collar was applied and she was positioned supine on a backboard. She was then transported to a local hospital via a ground ambulance. After assessment at the local hospital, she was transferred to a regional trauma center and admitted for surgery and treatment.

The ambulance was towed from scene and impounded by the State Highway Patrol, pending an investigation. A week later, it was released to the parent ambulance agency. The ambulance agency transferred the vehicle to the municipal facilities base operations complex, where it was located for this SCI investigation.

2009 CHEVROLET G4500 / AEV TYPE III AMBULANCE

Description

The 2009 Chevrolet G4500 chassis was manufactured in August 2008 and identified by the Vehicle Identification Number (VIN): 1GBKG316691xxxxxx. A placard confirmed that the vehicle conformed to all applicable Federal Motor Vehicle Safety Standards (FMVSS) in effect as of its date of manufacture. The chassis was a dual-rear wheel drive platform powered by a 6.6 liter, V-8 diesel engine linked to a 4-speed automatic transmission (**Figure 5**). The chassis had a 404 cm (159 in) wheelbase and 4-wheel power-assisted hydraulic disc brakes with anti-lock. At the time of the SCI inspection, the vehicle's electronic odometer reading was unknown.

Figure 5: Front left oblique view of the 2009 Chevrolet G4500 / AEV Type III ambulance.

The vehicle manufacturer's recommended tire size was LT225/75R16E, with recommended cold tire pressures of 450 kPa (65 PSI) front and 550 kPa (80 PSI) rear. It should be noted that the Chevrolet was equipped with an indirect Tire Pressure Monitoring System (TPMS). The TPMS warning indicator lamp was "Off" at the time of the crash, according to the data imaged from the Chevrolet's EDR. At time of the SCI inspection, the vehicle was equipped with Goodyear Wrangler HT tires of the manufacturer's recommended size at all six axle positions, mounted on OEM steel wheels. Specific tire data at the time of SCI inspection was as follows:

Position	Tire Identification Number (TIN)	Measured Pressure	Measured Tread Depth	Restriction	Damage
LF	MD1L MMJV 2311	538 kPa (78 PSI)	10 mm (12/32 in)	No	None *(grass/soil embedded between bead and wheel rim)*
LR inner	Unknown	538 kPa (78 PSI)	4 mm (5/32 in)	No	None
LR outer	MD1L MMJV 2311	552 kPa (80 PSI)	7 mm (9/32 in)	No	None
RR outer	MD1L MMJV 1411	Flat	4 mm (5/32 in)	No	Wheel rim abrasions
RR inner	Unknown	552 kPa (80 PSI)	6 mm (8/32 in)	No	None
RF	MD1L MMJV 2311	Flat	10 mm (12/32 in)	No	Tire debeaded

The interior of Chevrolet's cab was configured for the seating of two occupants. Both were forward-facing box-mounted seats with manual seat track and seat back recline adjustments, and featured 3-point lap and shoulder safety belt systems for manual restraint. Head restraints were integrated into the seat backs. A frontal air bag system provided supplemental restraint. Between the two seats and beneath the instrument panel's stereo and climate controls was a center console with an array of switches and communications equipment related to the ambulance's emergency response and operations activities. **Figure 6** depicts the driver's side of the Chevrolet's cab.

Figure 6: Interior view of the Chevrolet chassis' cab.

AEV Type III Ambulance

The Chevrolet chassis was completed as a Type III Certified "Star of Life" ambulance during secondary manufacturing in October 2008. This consisted of the affixation to the Chevrolet chassis of the AEV (American Emergency Vehicles) patient compartment module and installation of emergency services operational equipment such as warning lights, sirens, and radio communications. A placard confirmed that the AEV Type III ambulance conformed to Federal Specifications KKK-A-1822 in effect on its date of manufacture. This refers to the United States General Services Administration's (GSA) standard for minimum specifications, test parameters, and criteria for design, performance, equipment, and appearance of ambulances in order to display the six-pointed blue star with Rod of Asclepius (Star of Life).

Patient Compartment Module

The AEV patient compartment module had overall dimensions length x width x height of 417 x 223 x 241 cm (164.1 x 87.8 x 94.9 in). There were six exterior compartments (three on both side planes) and three occupant access doors (one right, two rear). The exterior compartments served for the storage of and curbside access to large emergency medical equipment and supplies, such as backboards, stair-chairs, trauma dressing kits, splints, oxygen cylinders, and roadside safety/vehicle equipment. Doublewide rear doors served for the loading and unloading of the stretcher, as well as entry/exit for the crew (**Figure 7**). There was also an occupant access door at the forward aspect of the right side.

Figure 7: Left rear oblique view of the AEV patient compartment module.

The interior of the patient compartment module served as a mobile emergency room for the treatment of emergent medical conditions in a pre-hospital environment. It was configured for the seating of up to five crewmembers surrounding a centralized stretcher for the patient, with numerous wall-mounted cabinets, shelves, and countertops for the storage of medical equipment and supplies. It should be noted that at the time of the SCI inspection, all salvageable equipment and supplies had already been removed from the vehicle by the parent ambulance agency; however, inspection of another of the agency's ambulances served for exemplar purposes (**Figure 8**).

Figure 8: Interior of an exemplar patient compartment module.

The patient compartment module's frame was constructed of 5x5 cm (2x2 in) square aluminum stock aligned in a ladder-frame pattern. All joints along the sill and roof side rail were welded and covered with 0.6 cm (0.25 in) aluminum fascia. The exterior surfaces were 0.3 cm (0.125 in) aluminum sheeting that was tack-welded to the frame. The walls and ceiling contained 1.4 cm (0.5 in) of dual-layer, closed-cell polymer insulation. A network of coated wires and hoses associated with the ambulance module's interior lighting, electrical, oxygen, and HVAC systems was intertwined within the insulation. Interior surfaces of the patient compartment module were covered with 0.6 cm (0.25 in) painted plywood. The assorted interior cabinetry was constructed of 1 cm (0.375 in) plywood with 0.6 cm (0.25 in) painted plywood fascia. Where necessary, 5x10 cm (2x4 in) wood studs provided additional structural support. Cabinetry doors were of various construction, including 1 cm (0.375 in) plywood with 0.3 cm (0.125 in) plexi-glass inlays, 0.6 cm (0.25 in) plexi-glass sliding doors inset within aluminum frames, and 0.6 cm (0.25 in) plexi-glass panels affixed to pneumatic cylinders.

On the left side of the patient compartment were four storage cabinets and two countertops, with an integrated seating position. The forward aspect, adjacent to the bulkhead, consisted of a large countertop, a switch panel with lighting and climate controls, wall-mounted radio communications equipment, and a large storage cabinet near the ceiling. Aft of the large countertop was the "CPR seat", a position so-named as its location within the chest area of the patient (with respect to the stretcher) placed its occupant in an optimal location to perform cardiopulmonary resuscitation (CPR) on the patient if needed. The seat consisted of two 45x33 cm (17.7x13 in) cushions integrated into the wall-mounted cabinetry, with a wall-mounted lap belt available for the manual restraint of its occupant. At the time of the crash, the crew had placed an Automated External Defibrillator (AED) capable of ECG monitoring within the CPR seat and secured it in place with the wall-mounted lap belt.

Aft of the CPR seat was another countertop shelf adjacent to the interior surfaces of the exterior storage compartment, with two large storage cabinets mounted to the ceiling above. At the forward aspect of the ambulance was a stack of storage cabinets, the cab/module pass-through, and the "Captain's Chair". The Captain's Chair provided seating for one occupant, and was so-named as its location near the communications equipment, the module's lighting and climate controls, and its proximity to the cab with rear-facing overview of the stretcher was frequently the location of the occupant providing administrative leadership for the crew.

The seat itself consisted of a 44 cm (17.2 in) wide by 46 cm (18.1 in) deep box-mounted seat cushion and an 84 cm (33 in) tall seat back with integrated head restraint. The Captain's Chair was equipped with a 3-point lap and shoulder safety belt for manual restraint, and also had a Child Restraint System (CRS) with 5-point harness integrated into the seat back. Folding armrests were present on both side aspects of the seat back for occupant comfort.

Behind the Captain's Chair, the heating, ventilation, and air-conditioning (HVAC) system was integrated into the bulkhead. Immediately to the right of the Captain's Chair seat back was a pass-through to the cab, which enabled visual and verbal communication between the driver and crew. Adjacent to the right wall was a stack of four cabinets for the storage of medical equipment bags and linen.

The right occupant access door occupied the forward aspect of the right plane, adjacent to the bulkhead's stack of storage cabinets. Next to the door opening was a tubular handrail that contained the refuse bin and biohazard sharp objects container. This separated the door opening from the three-passenger bench seat affixed above the right rear axle position. The bench seat consisted of two 84 cm (33 in) wide by 44 cm (17.3 in) deep cushions and was equipped with wall-mounted lap belts for manual restraint. The interior surfaces of the large exterior storage compartment occupied the right rear corner aspect of the patient compartment module's interior.

The central area of the patient compartment module remained open and served as the location of the patient stretcher. Affixed to the floor was a forward antler bracket and a rear locking clamp to secure the stretcher in place.

Vehicle Weight/Payload

The Chevrolet chassis was placarded by its manufacturer with a Gross Vehicle Weight Rating (GVWR) of 6,441 kg (14,200 lb). This was distributed as Gross Axle Weight Ratings (GAWR) of 2,087 kg (4,600 lb) front and 4,355 kg (9,600 lb) rear. A vehicle weight/payload certification sticker was located on the interior surface of the forward most exterior compartment door, placarded by the manufacturer of the AEV ambulance module. It declared that the curb weight of the overall vehicle after secondary manufacturing was 5,053 kg (11,140 lb). The curb weight at the axle locations was 1,941 kg (4,280 lb) front and 3,112 kg (6,860 lb) rear.

At the ambulance's date of manufacture, the minimum available payload allowed by the KKK-A-1822 specifications was 794 (1,750 lb). Based on the vehicle's placard, the calculated actual payload of the completed vehicle was 1,388 kg (3,060 lb). The SCI investigation included the inspection of another of the parent ambulance agency's vehicles for exemplar purposes. Based on this exemplar inspection, the estimated combined weight of the EMS equipment and supplies on-board the involved ambulance at the time of the crash was a minimum of 431 kg (950 lb). Information obtained during SCI interviews enabled the Investigator to calculate that the combined weight of the three occupants of the ambulance at the time of the crash was 259 kg (570 lb). Accordingly, it was concluded that the laden ambulance was not operating in excess of its available payload capacity at the time of the crash.

Exterior Damage

Damage to the exterior of the ambulance from the rollover crash was present on all planes of the vehicle. Overlapping damage patterns on the right side confirmed that a minimum of five - quarter turns. Direct contact on the right side began at the front bumper corner and extended the full 696 cm (274 in) length to the rear bumper corner (**Figure 9**). Damage consisted of body deformation and surface abrasions, and the structural integrity of the patient compartment module was compromised. The right wheelbase was shortened by 9 cm (3.4 in), and the outer tie rod was separated at its linkage. The right front mirror had been fractured from its stalk and was not with the vehicle.

Figure 9: Event 1 damage on the right plane of the AEV patient compartment module.

At the forward corner aspect of the patient compartment module, the corner frame rail was separated from the forward wall of the module. Abrasions and soil transfer were present along the roof side rail, with minor lateral deformation. The rear right exterior compartment was deformed at its lower aspect by surrounding frame deformation. It had been pried open post crash by the ambulance agency for salvage of equipment, and although the latch itself was not damaged, the compartment door could not be reclosed due the induced misalignment of the door frame. There was also separation of the right frame from the rear plane at the right rear corner.

Separation of the frame at the front and rear corners of the right plane during the rollover ultimately resulted in the compromised integrity of the patient compartment module as the frame subsequently separated at other locations during the duration of the rollover sequence. This included separation of the corner frame rail of the left wall from the front plane at the left front corner of the module, as well as the separation of the roof structure along the entire left roof side rail. As a result of this frame separation, the overall structure of the module was angled to the right. This displacement resulted in integrity loss at both forward corners of the patient compartment module (**Figure 10**).

Figure 10: Integrity loss to the patient compartment module as a result of structural compromise.

Figure 11: Separation of the roof structure and left roof side rail of the module's frame.

The loading doors of the rear plane remained intact and operational, though they were misaligned as a result of induced door frame shift associated with the module's structural deformation. All compartment doors on the left plane also remained intact and operational. There was no damage or deformation to the diesel fuel filler nozzle located forward of the left rear axle, nor to the 125 volt / 20 ampere shoreline electrical connection port aft of the forward compartment door. Direct damage on the left plane was located on protruding edge surfaces, and consisted of abrasions and soil transfer.

It was observed during the SCI investigation that application of a force to the exterior surface of the right plane resulted in the corresponding lateral shift of the entire patient compartment structure, due largely in part to the separation of the module's frame in multiple locations. In its static state, the entire roof structure was shifted 10-19 cm (4-8 in) right laterally (**Figure 11**). The Truck Deformation Classification (TDC) assigned to the ambulance for the rollover sequence damage pattern (Event 1) was 00RDAOA.

Event Data Recorder

The Chevrolet chassis was equipped with an air bag Sensing and Diagnostic Module (SDM) mounted under the front left seat. The SDM had EDR capabilities to record two different event types, termed "Non-Deployment" and "Deployment". The SDM could store a combination of up to three events (two different deployment and one locked non-deployment). Non-deployment events could be overwritten after 250 ignition cycles, whereas deployment events could not be overwritten.

Associated to each respective event was a 2.5-second pre-crash buffer that recorded Accelerator Pedal Position (%), Vehicle Speed (mph), Engine Speed (RPM), Percent Throttle, and Brake Switch Circuit State data. For the 0.5 and 1-second pre-crash intervals, the EDR also recorded Cruise Control usage, Engine Torque, and Reduced Engine Power Mode data.

The EDR monitored and measured vehicle acceleration in both the longitudinal and lateral directions, and the recording of each distinct crash event could be triggered by a frontal (longitudinal), a side (lateral), and/or a rollover (vertical) crash pulse with a measured Vehicle Velocity Change greater than 8 km/h (5 mph). At Algorithm Enable (AE) and recognition of a longitudinal or lateral event, the EDR had the capacity to record 300 milliseconds of post-AE longitudinal and lateral delta-V data in 10 millisecond intervals for a non-deployment event.

The SCI Investigator imaged the Chevrolet's EDR data using Bosch Crash Data Retrieval (CDR) hardware with software version 4.1.2 via a direct connection to the module. The data was subsequently read using CDR software version 4.3. The imaged data contained one stored event, termed "Non-Deployment". This event had occurred on the ignition counter number of 6900, and the Supplemental Inflatable Restraint (SIR) Warning Lamp Status was OFF. The Driver's Belt Switch Circuit Status was reported as "Buckled". Multiple event data indicated that there were four events not recorded that were associated with the non-deployment event. All triggers were detected as an extended concatenated event.

The first trigger after AE was recorded as a frontal (longitudinal) event at zero milliseconds, corresponding to first-quarter turn of the rollover sequence (Event 1). This data set had the following recorded pre-crash buffer data:

Time (seconds)	-2.5	-2	-1.5	-1	-0.5
Vehicle Speed	121 km/h (75 mph)	119 km/h (74 mph)	114 km/h (71 mph)	108 km/h (67 mph)	100 km/h (62 mph)
Brake Switch Circuit Status	OFF	OFF	OFF	OFF	OFF
Accelerator Pedal Position	13%	6%	0%	0%	0%
Percent Throttle	12%	7%	2%	0%	0%
Engine Speed	2688 RPM	2560 RPM	2432 RPM	2112 RPM	1728 RPM
Cruise Control Active	-	-	-	NO	NO
Engine Torque	-	-	-	-105 N-m (-77.8 lb-ft)	-120 N-m (-88.9 lb-ft)
Reduced Engine Power Mode	-	-	-	OFF	OFF

The maximum SDM Recorded Vehicle Velocity Change (delta-V) occurred 260 milliseconds after AE and had a longitudinal component of -10.6 km/h (-6.59 mph). Complete event recording was reported. The imaged SDM data is included at the end of this technical report as **Attachment A**.

Interior Damage

The interior of the ambulance, including the Chevrolet chassis' cab and the patient compartment module, were thoroughly inspected for crash-related and occupant contact damage. It should be noted, however, that due to pending legal implications the SCI Investigator's inspection of the ambulance was restricted to a non-invasive, visual-only inspection that was monitored by corresponding representatives.

The interior of the Chevrolet chassis' cab sustained minor damage as a result of the crash. There was no intrusion associated with the exterior crash forces; however, the right front glazing was disintegrated during the rollover sequence. Remaining damage within the cab's interior consisted of occupant contact to the armrest, windshield, and review mirror. The armrest was deformed right laterally as a result of loading from the driver's right flank during the rollover sequence. The windshield glazing was cracked in a star-shaped pattern above the steering wheel, attributed to contact from the driver's left hand during the final -quarter turn of the rollover sequence. His kinematics during that time also resulted in contact to the rearview mirror, which was displaced from its windshield mount, by the driver's shoulder. His head also contacted the windshield, resulting in a second star-shaped pattern in the area of the rearview mirror.

Moderate interior damage was sustained by the patient compartment as a result of the rollover crash, including structural integrity loss, cabinetry separation, and occupant contact. This damage was present to the front, right, left, and top planes. Integrity loss was associated with the aforementioned structural displacement and separation of the front corner frame rails and left roof side rail as previously described. Ceiling components subsequently became dislodged and were displaced from the ceiling, including the painted plywood fascia, interior lighting fixtures, and polymer insulation.

Cabinetry separation occurred at the rear aspect of both the left and right interior walls. On the right wall, aft of the bench seat, structural displacement resulted in the separation of the overhead cabinet as the right wall was displaced 15 cm (5.9 in) right laterally. This included the separation of the wall from the frame of the right rear exterior compartment, resulting in integrity loss between the interior of the patient compartment module and the interior of the right rear exterior storage compartment (**Figure 12**).

Figure 12: Wall and cabinetry separation at the right rear aspect of the patient compartment interior.

At the rear aspect of the left wall, all three upper cabinets were completely separated from their original mounting locations. The area of cabinetry separation measured 138 cm (54.3 in) long, 52 cm (20.5 in) deep, and 50 cm (19.7 in) tall.

During the crash sequence, these cabinets became dislodged by a combination of the forces associated with the rollover and the separation of the frame structure at the left roof side rail. Subsequently, the separated cabinets moved right laterally and contacted the occupants and right wall. At rest, these cabinets and their components were located scattered throughout the patient compartment and laying on top of the occupants by the Field Supervisor and off-duty medical doctor. They were removed during post-crash emergency operations activities, and were not with the vehicle at the time of inspection. **Figure 13** depicts the upper rear aspect of the left wall at the time of SCI inspection, while a similar view of an exemplar patient compartment in **Figure 14** serves for comparison purposes.

Figure 13: Cabinetry separation at the left upper rear aspect of the patient compartment interior.

Figure 14: Left upper rear aspect cabinetry within an exemplar patient compartment interior.

Further cabinetry separation was present at the forward aspect of the patient compartment at the bulkhead. As a result of the aformentioned structure separation, the forward wall separating the interior of the cab from the interior of the patient compartment was completely displaced. This enabled the exposure of the electrical systems enclosed within the cabinetry behind the driver's seating position, as well as the displacement of the locking controlled substance medication cabinet above the pass-through. The stack of cabinetry at the front right aspect of the patient compartment module's interior was also deformed and displaced by the aformentioned structural displacement (**Figure 15**).

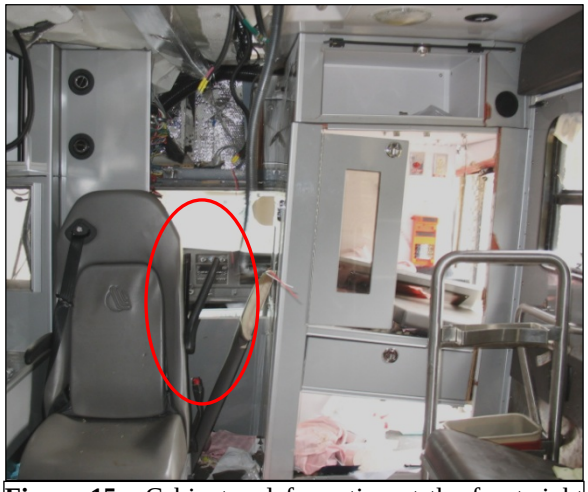


Figure 15: Cabinetry deformation at the front right aspect of the patient compartment (*note deformed Captain's Chair armrest and deformed handrail*).

Damage from occupant contact within the patient compartment's interior was identified on the Captain's Chair and the tubular handrail forward of the bench seat. On the Captain's Chair, the left armrest (with respect to the seat's orientation) was deformed laterally toward the right wall of the patient compartment as a result of occupant loading. This lateral deformation measured a maximum of 11 cm (4.3 in) at the end of the armrest. The sharp objects container holder within the handrail forward of the bench seat was also deformed, with a maximum longitudinal deformation extent of 2.5 cm (1 in). The corresponding polymer sharps container was disintegrated.

Manual Restraint Systems

The cab of the Chevrolet chassis was equipped with manual restraint systems for both seating positions. Each was a 3-point lap and shoulder safety belt system that consisted of continuous loop webbing with a sliding latch plate, and was height-adjustable at its respective B-pillar-mounted D-ring anchor position. The driver's safety belt retracted onto an Emergency Locking Retractor (ELR), while the front right passenger's safety belt retracted onto an ELR/Automatic Locking Retractor (ALR). At the time of the SCI inspection, both belt systems were intact, operational, and exhibited evidence of historical use. Both D-ring anchors were adjusted to their full-down positions. The webbing of the driver's safety belt was gathered in the latch plate at a distance 92 cm (36.2 cm) from the lower anchor (**Figure 16**). There was also a sharp abrasion on the webbing from the D-ring at a distance 195 cm (76.8 in) from the lower anchor. This evidence confirmed belt usage by the driver at the time of the crash.

Figure 16: Driver's safety belt webbing gathered within the latch plate.

The interior of the patient compartment module of the AEV ambulance was equipped with manual safety belt systems at all five seating positions. All manual restraint systems within the patient compartment utilized continuous loop webbing. The lap belts for the CPR seat and bench seat retracted onto ELRs mounted to the patient compartment wall. These belt systems displayed minor to no evidence of historical use. The Captain's Chair was equipped with an integrated 3-point lap and shoulder safety belt system with box-mounted ELR, as well as a stow-away 5-point Child Restraint System (CRS) integrated into the high-seat back. Both of these restraint systems displayed minor to no evidence of historical use; therefore restraint usage by the female Paramedic crewmember could not be confirmed or disputed based solely on the post-crash condition of the 3-point lap and shoulder safety belt system.

Supplemental Restraint Systems

The cab of the Chevrolet chassis was equipped with a frontal air bag system for supplemental restraint. This system consisted of advanced dual-stage air bags available for the driver and front right passenger, mounted within the steering wheel hub and top instrument panel. The manufacturer of the vehicle has certified that the Chevrolet's air bags were compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. Both air bags were installed by the original manufacturer and had not required any service/maintenance prior to the crash. The rollover sequence (Event 1) did not achieve a longitudinal crash pulse of sufficient magnitude to deploy the vehicle's frontal air bag system.

Patient Stretcher

The patient stretcher was a 6500 Power-PRO XT Power Ambulance Cot that was manufactured by Stryker, serial number (S/N): 060340051. Based on this serial number, it was manufactured in March of 2006 and was constructed of a tubular aluminum frame with circumferential weld joints and steel hardware fasteners. The X-frame supporting the mattress platform featured power raise/lower capabilities with infinite height positions between a minimum of 36 cm (14 in) and a maximum of 105 cm (41.5 in). The mattress platform featured 0-73 degrees of positive backrest angular adjustment via a manually controlled gas-pressure cylinder. In a similar fashion, the leg portion featured 15 degrees of positive angular adjustment. Overall dimensions of the stretcher were 58 cm (23 in) wide and 206 cm (81 in) long. A placard declared that the load capacity limit of the stretcher was 318 kg (700 lb). An exemplar Stryker stretcher is depicted in **Figure 17**.

Figure 17: Exemplar Stryker Power-PRO XT stretcher.

Electrical power for the raise/lower capability was supplied by a removable 24 volt nickel-cadmium (NiCad) direct current battery pack, manufactured by DeWalt. When depleted, the battery was removed from its port and placed in a docking station for automatic charging via a 120 / 220 volt alternating current connection. The Stryker stretcher was equipped with a multi-point harness system for manual restraint of its occupant (patient). This multi-point harness system included a lateral leg strap, lateral lap strap, and shoulder/chest harness, in which a pair of shoulder straps buckled into a chest strap. The safety belt webbing was continuous loop, and all straps included locking latch plates for length adjustment. Exact adjusted length of the straps at the time of the crash is unknown; however, ambulance agency policy requires that all patients must be securely restrained at all times by all straps when positioned on the stretcher. Although heavy historical use masked loading evidence, the post crash positioning of the patient and the post-crash observations of emergency services personnel confirmed complete restraint usage.

Stretcher Anchoring System

The stretcher was secured in place within the patient compartment module via a Model 6370 Cot Fastener System. It was manufactured by Stryker in September of 2009, as identified by the manufacturer's S/N: 080940959. The system consisted of a forward antler bracket and rearward locking-clamp mechanism. The antler bracket cradled the forward portion (location of the patient's head area) of the stretcher's frame, while the vertically-oriented locking mechanism clamped around a pin protruding from the stretcher's lower frame rail. Combined, these two components restricted the lateral and longitudinal movement of the stretcher.

During the rollover sequence, centrifugal and non-horizontal forces associated with the crash induced vertical movement to the stretcher (with respect to the patient compartment module's floor). Due to the location of the locking-clamp mechanism on the left aspect of the stretcher, the mass of the stretcher and aforementioned crash forces induced a positive moment of inertia about the longitudinal axis of the locking clamp. The vertical orientation of the clamp translated an equivalent perpendicular normal force through the anchor pin to the stretcher's frame to restrict the lateral movement of the stretcher.

As the rollover sequenced progressed, the magnitude of the inertial forces increased until the tensile-load strength of the tubular aluminum frame was exceeded. At that time, a 16 cm (6.3 in) section of the tubular aluminum surrounding the anchor pin yielded from the stretcher's frame. Subsequently, the stretcher's movement became unrestricted. **Figure 18** depicts the locking-clamp mechanism with the stretcher's anchor pin still engaged within the clamp at the time of the SCI inspection. **Figure 19** depicts an exemplar locking-clamp mechanism with a similar stretcher secured for comparison purposes.

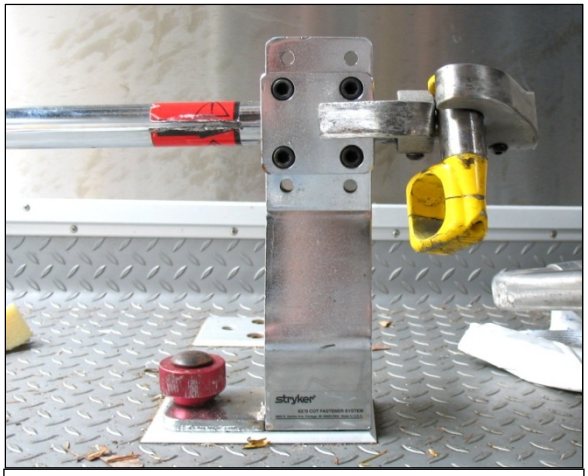


Figure 18: Locking-clamp mechanism of the Stryker Cot Fastener System at the time of the SCI inspection (*note that the anchor pin is still engaged within the clamp*).

Figure 19: Exemplar Stryker Cot Fastener System with a similar stretcher secured.

Stretcher Damage

The Stryker Stretcher sustained severe damage as a result of the crash. Numerous frame rail members were yielded in varying locations and several joint welds had fractured. The forward support frame cradled by the antler bracket was separated at its structural hinge joints. The tubular aluminum of the mattress box frame was fractured in multiple locations, and the mattress support panels were deformed and buckled. Two of the four hinge mounts attaching the mattress box frame to the lower X-frame were also separated. The anchor pin and the 16 cm (6.3 in) section were missing from the lower left frame rail. **Figures 20** and **21** provide overall views of the Stryker stretcher at the time of the SCI inspection. It should be noted that the positioning of the manual restraint safety belt straps was performed post crash by emergency response personnel in an attempt to hold the structural components together. No positional adjustments could made to the stretcher or its components by the SCI Investigator at the time of inspection to test the stretcher's structural integrity due to pending legal implications.

Figure 20: Overall rearward-facing view of the Stryker patient stretcher at the time of the SCI inspection.

Figure 21: Overall forward-facing view of the Stryker patient stretcher (*note missing section of lower frame rail*).

2009 CHEVROLET G4500 / AEV TYPE III AMBULANCE OCCUPANTS

Driver Demographics

Age / Sex:	29 years / Male
Height:	170 cm (67 in)
Weight:	100 kg (220 lb)
Eyewear:	None
Seat Type:	Box-mounted, forward facing, with integrated head restraint
Seat Track Position:	Between middle and full-rear
Manual Restraint Usage:	3-point lap and shoulder safety belt
Usage Source:	Vehicle inspection
Air Bags:	None deployed
Alcohol/Drug Data:	None
Egress from Vehicle:	Exited vehicle without assistance
Transport from Scene:	Ground ambulance to a local hospital
Medical Treatment:	Treated and released within a 24-hour period

Driver Injuries

Inj No.	Injury	AIS 2005/08	Injury Source	Confidence Level
1	Anterior scalp abrasion (top of head)	110202.1,5	Windshield	Certain
2	Anterior scalp contusion	110402.1,5	Windshield	Certain
3	Left knee contusion	810402.1,2	Left lower instrument panel/knee bolster	Certain
4	Lumbar strain	640678.1,8	Inboard seat back-mounted armrest	Probable

Source: Medical Records; Interview (other: ambulance agency administration)

Driver Kinematics

The 29-year-old male driver was seated in the box-mounted seat. The seat track was adjusted to a position between middle and full-rear. He was restrained by the manual 3-point lap and shoulder safety belt system, though his exact belt positioning is unknown.

The driver initiated a slight right lateral trajectory as the vehicle initiated a CCW yaw. His torso contacted and loaded the safety belt webbing as the ELR engaged, keeping his body in position. As the vehicle achieved 90 degrees of rotation and entered the median, the driver maintained his right lateral trajectory as the vehicle began to roll right laterally. He maintained contact with the safety belt webbing, and his right flank contacted the armrest mounted to the inboard (right) aspect of the seat back.

During the early stages of the rollover sequence, the driver remained restrained by the safety belt. However, as the rollover sequence progressed and the centrifugal forces increased, the driver was directed left laterally. His left knee contacted the left lower instrument panel/knee bolster, resulting in the left knee contusion.

As the vehicle surpassed three -quarter turns, non-horizontal forces and the mass of the driver with respect to gravity enabled the driver's left shoulder to slide out of the shoulder belt, which allowed his torso to move forward. Accordingly, as the vehicle completed the rollover sequence, the driver initiated a forward and right lateral trajectory toward the center of the windshield. His left hand contacted the windshield in front of the steering wheel, resulting in cracks to the interior surface of the glazing. His head and right shoulder contacted the windshield and rearview mirror, respectively, cracking the interior surface of the glazing and fracturing the mirror from its mount. This contact resulted in the scalp abrasion and contusion.

As the vehicle came to rest, the driver remained out of position within the seat and was partially suspended from the safety belt with respect to the vehicle's orientation. His abdomen and lap remained restrained by the safety belt webbing, which had gathered the webbing within the forward aspect of the latch plate. Due to the positioning of the vehicle on its right side, the driver was able to slide his body downward (toward the right side) and out of the safety belt. He then climbed upward, opened the left front door, and pulled himself up and out of the cab without assistance.

After jumping to the ground, the driver moved to the rear of the vehicle where he was met by the Field Supervisor and off-duty medical doctor who had just arrived on scene. As emergency response personnel arrived, the driver was soon relieved of his efforts to assist in the removal of the patient compartment occupants and received emergency medical care. He was transported via ground ambulance to a local hospital, where he was treated and released within a 24-hour period.

Captain's Chair Occupant Demographics

Age / Sex:	21 years / Female
Height:	166 cm (65 in)
Weight:	68 kg (150 lb)
Eyewear:	None
Seat Type:	Box-mounted
Seat Track Position:	Rearmost (with respect to the seat's orientation)
Manual Restraint Usage:	None
Usage Source:	Vehicle inspection
Air Bags:	None available
Alcohol/Drug Data:	Positive drug screen for marijuana
Egress from Vehicle:	Removed from vehicle due to perceived injuries
Transport from Scene:	Ground ambulance to a local hospital
Medical Treatment:	Transferred to a regional trauma center and admitted for 9 days

Captain's Chair Occupant Injuries

Inj No.	Injury	AIS 2005/08	Injury Source	Confidence Level
1	Right pelvic ring fracture, NFS, vertically oriented fractures through the right superior pubic ramus and the posterior aspect of the right inferior pubic ramus	856100.2,1	Right interior wall	Probable
2	Left acetabular fracture, complex, transverse, involving the left posterior column	856261.2,2	Right interior wall	Probable
3	Left hip dislocation, (the left femur is posteriorly dislocated and perched on the posterior acetabular apex)	873030.2,2	Right interior wall	Probable
4	Right medial orbital wall fracture	251231.2,1	Right interior wall	Probable
5	Orbital eye contusion, right	210402.1,1	Right interior wall	Probable
6	Right subconjunctival hemorrhage	240416.1,1	Right interior wall	Probable
7	Laceration above right eye, less than 2 cm, (eyebrow area)	210602.1,7	Right interior wall	Probable
8	Right cheek laceration, (just below right eye)	210602.1,1	Right interior wall	Probable
9	Left hand laceration, 2-3 cm laceration in web space between the 2nd and 3rd fingers	710602.1,2	Right interior wall	Probable
10	Lower back contusion, (near lumbar spine area)	410402.1,8	Right interior wall	Probable

Source: Medical Records; Interview (other: ambulance agency administration)

Captain's Chair Occupant Kinematics

The 21-year-old female Paramedic was seated within the rear-facing Captain's Chair, which was adjusted to a rearmost track position (with respect to its orientation). The female Paramedic was not utilizing the available lap and shoulder safety belt system integrated within the seat. Prior to the crash, the Paramedic was involved in emergency medical care activities related to the treatment of the 79-year-old female patient.

The female Paramedic initiated a slight left lateral trajectory (with respect to her rear-facing orientation) as the vehicle entered the CCW yaw. As it achieved 90 degrees of rotation, her left flank contacted the armrest mounted to the left aspect of the seat back. She maintained her left lateral trajectory as the vehicle initiated the right side-leading rollover, and her left flank subsequently loaded the armrest.

The Paramedic's contact and loading to the armrest was prolonged through the early stages of the rollover sequence, which deformed the armrest 11 cm (4.3 in) toward the right side of the vehicle. Her body then rotated off of the armrest as she maintained her left lateral trajectory toward the right side of the patient compartment module due to the centrifugal forces associated with the rollover.

As the vehicle progressed into the rollover, the Paramedic contacted the upper aspect of the right occupant access door and the ceiling with her head, face, shoulders, and chest. This contact resulted in traumatic face and chest injuries. For the remainder of the rollover sequence, the Paramedic remained out of position within the upper aspect of the right occupant access door due to the centrifugal forces associated with the rollover.

During the rollover sequence, miscellaneous equipment, medical supplies, cabinetry, and the patient stretcher became dislodged/separated from their original locations. This multitude of objects began to contact the female Paramedic during the final -quarter turn, and essentially buried her as the vehicle came to rest. The combination of the static weight of these objects and their corresponding trajectories resulted in unspecified soft tissue injuries.

Post-crash, the Paramedic was removed from the patient compartment module of the vehicle due to her perceived injuries by emergency response personnel. She was transported via ground ambulance to a local hospital for evaluation, and was subsequently transferred to a regional trauma center. There, she received surgical treatment and was admitted for nine days.

Stretcher Occupant Demographics

Age / Sex:	79 years / Female
Height:	137 cm (54 in) bilateral amputee
Weight:	91 kg (200 lb)
Eyewear:	Unknown
Seat Type:	Other seat type (specify: EMS stretcher)
Seat Track Position:	Not adjustable
Manual Restraint Usage:	Multi-point harness system
Usage Source:	Vehicle inspection / Interview
Air Bags:	None available
Alcohol/Drug Data:	None
Egress from Vehicle:	Removed from vehicle by medical examiner
Transport from Scene:	None
Medical Treatment:	None (pronounced deceased at scene)

Stretcher Occupant Injuries

Inj No.	Injury	AIS 2005/08	Injury Source	Confidence Level
1	Laceration of brainstem	140212.6,8	Right interior wall	Probable
2	Thoracic aorta transection (descending)	420210.5,4	Right interior wall	Probable
3	Basilar skull fracture, “hinge type”	150206.4,8	Right interior wall	Probable
4	Right hemothorax (600 cc of blood in right chest)	442200.3,1	Right interior wall	Probable
5	Lung contusion NFS	441402.3,9	Right interior wall	Probable
6	Atlanto-occipital dislocation	650208.2,6	Right interior wall	Probable
7	Right clavicle fracture	750500.2,1	Shoulder strap webbing of multi-point harness system	Probable
8	Left clavicle fracture	750500.2,2	Shoulder strap webbing of multi-point harness system	Probable
9	Fractured spine between T3-T4	650416.2,7	Right interior wall	Probable
10	Sternum fracture	450804.2,4	Right interior wall	Probable
11	Multiple rib fractures, NFS	450210.2,9	Right interior wall	Probable
12	Right eye contusion	210402.1,1	Right interior wall	Probable
13	Right conjunctiva injury	240416.1,1	Right interior wall	Probable

Source: Autopsy; Interview (other: ambulance agency administration)

Stretcher Occupant Kinematics

The 79-year-old female patient was positioned semi-Fowler’s (anatomical sitting position of comfort with torso slightly reclined and legs extended forward) on the Stryker stretcher. She was restrained by the multi-point harness system, which was adjusted with all loose slack removed. Restraint usage was confirmed by the post-crash observations of the ambulance agency’s personnel, medical examiner, and an internal operations policy during SCI interviews.

The female patient initiated a left lateral trajectory with respect to her rear-facing orientation in response to the CCW yaw and rollover sequence initiation. Her body movement was restricted by the multi-point harness system, and she remained semi-Fowler’s on the stretcher.

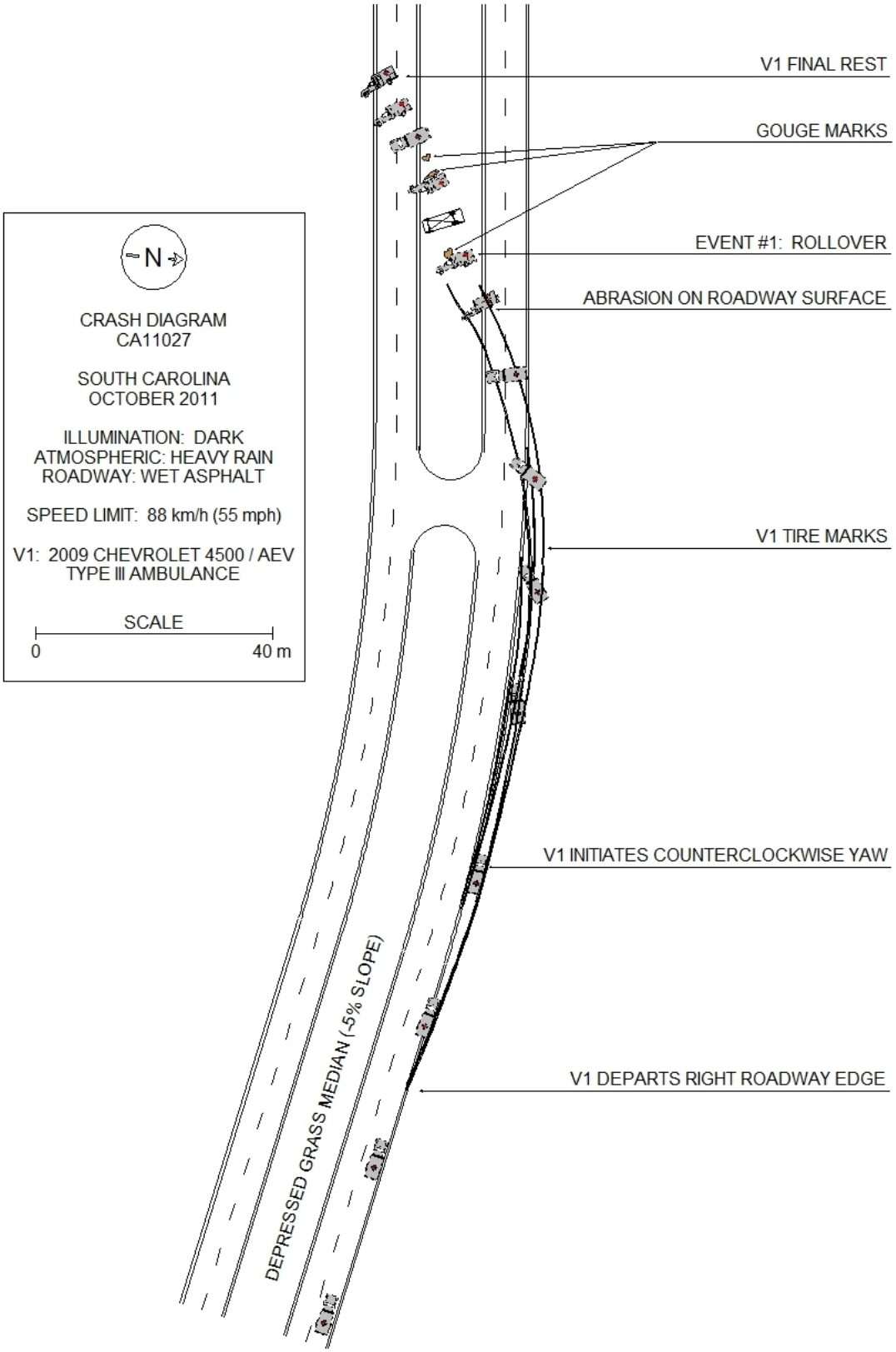
As the ambulance progressed through the rollover sequence, the patient maintained a left lateral trajectory. Her body mass loaded the multi-point harness system, and she remained on the stretcher. Due to the severe magnitude of the non-horizontal rollover forces combined with the patient’s mass, a left lateral rotation about the stretcher’s longitudinal axis was initiated. The moment of this inertial force was transferred through the stretcher’s frame to the anchor pin.

As the magnitude of these forces increased during the rollover sequence, the tensile-load yield strength of the stretcher's aluminum frame was exceeded and a section of the frame separated. This allowed the stretcher's movement to progress unrestricted. Thus, although the patient was still restrained by the multi-point harness system, she was now subjected to the physical kinematics associated with an unrestrained occupant/object.

As the vehicle completed the rollover sequence, displaced equipment/supplies and separated cabinetry began to contact the stretcher occupant. At the same time, the stretcher itself moved laterally toward the right interior wall of the patient compartment. Subsequently, the patient was subjected to contact with the right wall, upper right wall cabinetry, and ceiling, with the distributed mass of the stretcher loading her anterior body surfaces The combination of these contacts resulted in multiple traumatic injuries to her head and chest.

The patient remained restrained to the stretcher by its multi-point harness system as the vehicle came to rest. The stretcher was overturned, such that the patient was face down toward the right interior wall. She did not have a palpable carotid pulse and was subsequently pronounced deceased at the scene.

CRASH DIAGRAM



ATTACHMENT A:

2009 Chevrolet G4500 Chassis EDR Data

IMPORTANT NOTICE: Robert Bosch LLC and the manufacturers whose vehicles are accessible using the CDR System urge end users to use the latest production release of the Crash Data Retrieval system software when viewing, printing or exporting any retrieved data from within the CDR program. Using the latest version of the CDR software is the best way to ensure that retrieved data has been translated using the most current information provided by the manufacturers of the vehicles supported by this product.

CDR File Information

User Entered VIN	1GBKG316691******
User	
Case Number	
EDR Data Imaging Date	11/04/2011
Crash Date	
Filename	CA11027_V1_ACM.CDRX
Saved on	Friday, November 4 2011 at 12:08:27
Collected with CDR version	Crash Data Retrieval Tool 4.1.2
Reported with CDR version	Crash Data Retrieval Tool 4.3
EDR Device Type	Airbag Control Module
Event(s) recovered	Non-Deployment

Comments

No comments entered.

Data Limitations

Recorded Crash Events:

There are two types of recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event records data but does not deploy the air bag(s). The minimum SDM Recorded Vehicle Velocity Change, that is needed to record a Non-Deployment Event, is five MPH. A Non-Deployment Event may contain Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event can be overwritten by an event that has a greater SDM recorded vehicle velocity change. This event will be cleared by the SDM, after approximately 250 ignition cycles. This event can be overwritten by a second Deployment Event, referred to as Deployment Event #2, if the Non-Deployment Event is not locked. The data in the Non-Deployment Event file will be locked, if the Non-Deployment Event occurred within five seconds of a Deployment Event. A locked Non Deployment Event cannot be overwritten or cleared by the SDM.
The second type of SDM recorded crash event is the Deployment Event. It also may contain Pre-Crash and Crash data. The SDM can store up to two different Deployment Events. If a second Deployment Event occurs any time after the Deployment Event, the Deployment Event #2 will overwrite any non-locked Non-Deployment Event. Deployment Events cannot be overwritten or cleared by the SDM. Once the SDM has deployed an air bag, the SDM must be replaced.

Data:

-SDM Recorded Vehicle Velocity Change reflects the change in velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Velocity Change is the change in velocity during the recording time and is not the speed the vehicle was traveling before the event, and is also not the Barrier Equivalent Velocity. For Deployment Events, the SDM will record 220 milliseconds of data after Deployment criteria is met and up to 70 milliseconds before Deployment criteria is met. For Non-Deployment Events, the SDM can record up to the first 300 milliseconds of data after algorithm enable. Velocity Change data is displayed in SAE sign convention.

-The CDR tool displays time from Algorithm Enable (AE) to time of Deployment command in a Deployment event and AE to time of maximum SDM recorded vehicle velocity change in a Non-Deployment event. Time from AE begins when the first air bag system enable threshold is met and ends when Deployment command criteria is met or at maximum SDM recorded vehicle velocity change. Air bag systems such as frontal, side, or rollover, may be a source of an enable. The time represented in a CDR report can be that of the enable of one air bag system to the Deployment time of another air bag system.

-Maximum Recorded Vehicle Velocity Change is the maximum square root value of the sum of the squares for the vehicle's combined "X" and "Y" axis change in velocity.

-Event Recording Complete will indicate if data from the recorded event has been fully written to the SDM memory or if it has been interrupted and not fully written.

-SDM Recorded Vehicle Speed accuracy can be affected by various factors, including but not limited to the following:
- -Significant changes in the tire's rolling radius
- -Final drive axle ratio changes
- -Wheel lockup and wheel slip

-Brake Switch Circuit Status indicates the open/closed state of the brake switch circuit.

-Pre-Crash data is recorded asynchronously.

-Pre-Crash Electronic Data Validity Check Status indicates “Data Invalid” if:
    -The SDM receives a message with an “invalid” flag from the module sending the pre-crash data
    -No data is received from the module sending the pre-crash data
    -No module is present to send the pre-crash data
-Driver’s and Passenger’s Belt Switch Circuit Status indicates the status of the seat belt switch circuit.
-The Time Between Non-Deployment to Deployment Events is displayed in seconds. If the time between the two events is greater than five seconds, “N/A” is displayed in place of the time. If the value is negative, then the Deployment Event occurred first. If the value is positive, then the Non-Deployment Event occurred first.
-If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded.
-The ignition cycle counter relies upon the transitions through OFF->RUN->CRANK power-moding messages, on the GMLAN communication bus, to increment the counter. Applying and removing of battery power to the module will not increment the ignition cycle counter.
-All data should be examined in conjunction with other available physical evidence from the vehicle and scene

Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Status Data (Pre-Crash) is transmitted to the SDM, by various vehicle control modules, via the vehicle’s communication network.
-The Belt Switch Circuit is wired directly to the SDM.

01006_SDMCG_r002

Multiple Event Data

Associated Events Not Recorded	4
Event(s) was an Extended Concatenated Event	Yes
An Event(s) was in Between the Recorded Event(s)	No
An Event(s) Followed the Recorded Event(s)	Yes
The Event(s) Not Recorded was a Deployment Event(s)	No
The Event(s) Not Recorded was a Non-Deployment Event(s)	Yes

System Status At AE

Low Tire Pressure Warning Lamp (If Equipped)	OFF
Vehicle Power Mode Status	Run
Remote Start Status (If Equipped)	Inactive
Run/Crank Ignition Switch Logic Level	Active

Pre-crash data

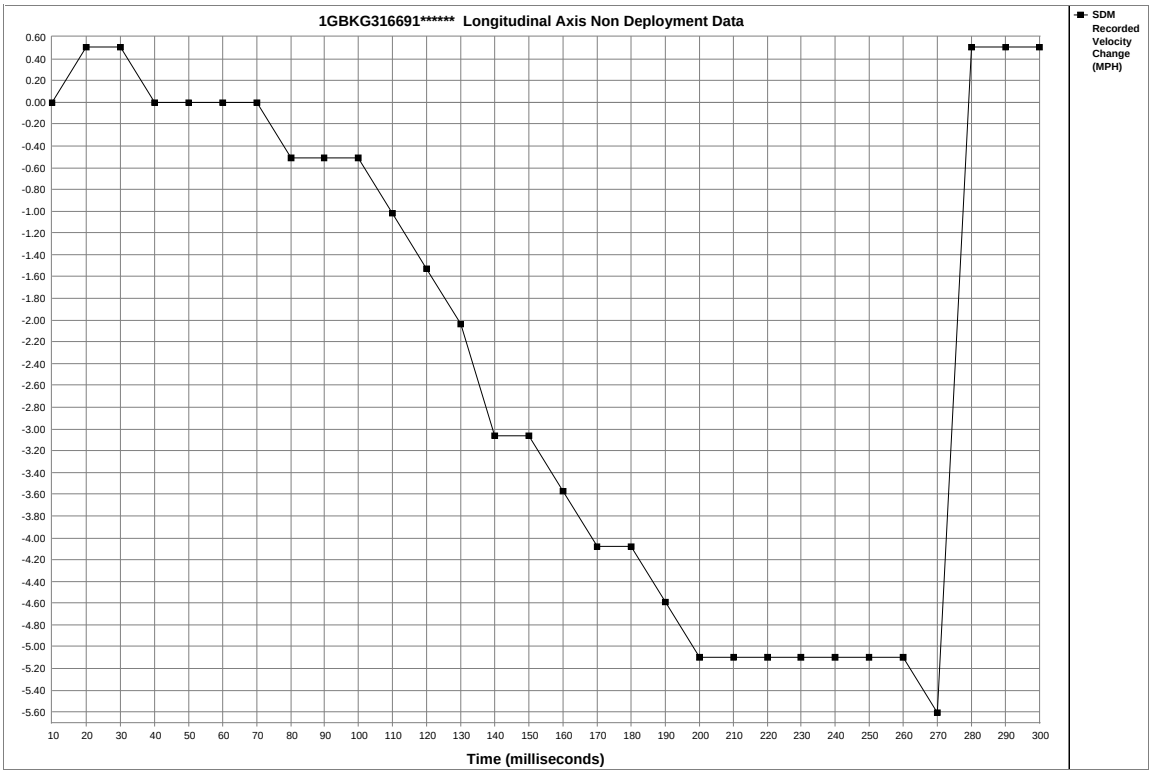
Parameter	-1.0 sec	-0.5 sec
Reduced Engine Power Mode	OFF	OFF
Cruise Control Active (If Equipped)	No	No
Cruise Control Resume Switch Active (If Equipped)	No	No
Cruise Control Set Switch Active (If Equipped)	No	No
Engine Torque (foot pounds)	-77.82	-88.88

Pre-Crash Data

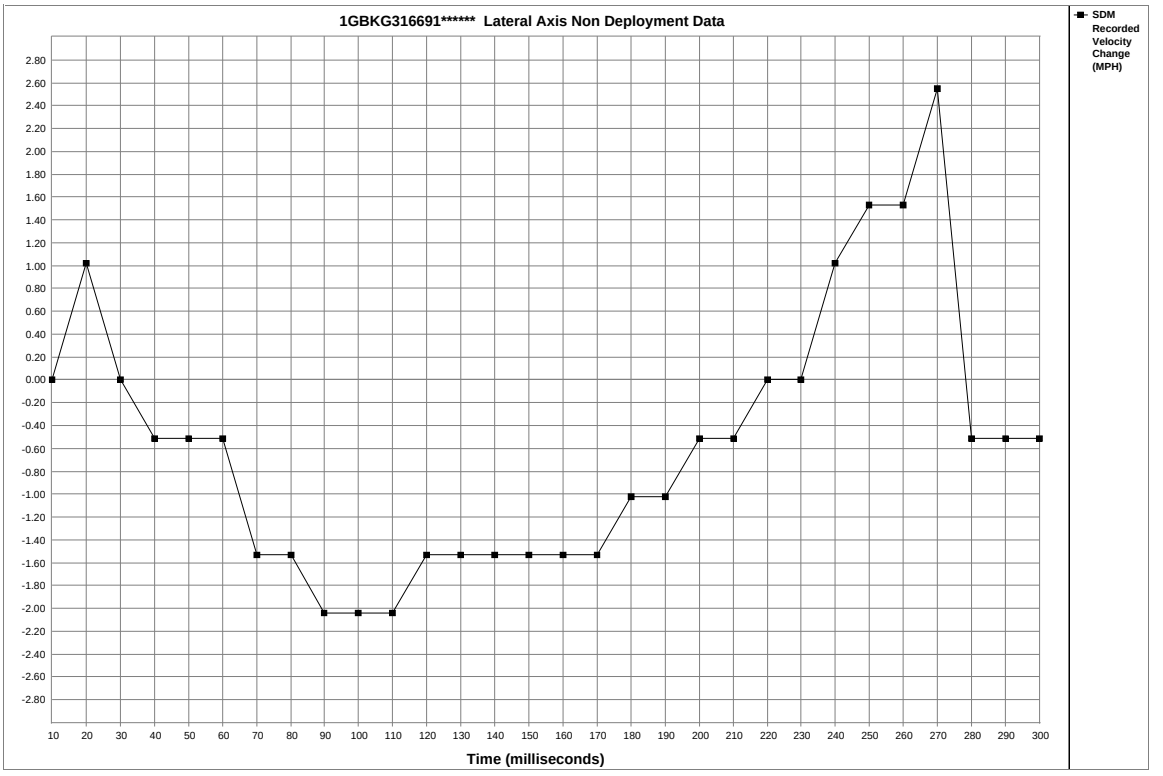
Parameter	-2.5 sec	-2.0 sec	-1.5 sec	-1.0 sec	-0.5 sec
Accelerator Pedal Position (percent)	13	6	0	0	0
Vehicle Speed (MPH)	75	74	71	67	62
Engine Speed (RPM)	2688	2560	2432	2112	1728
Percent Throttle	12	7	2	0	0
Brake Switch Circuit State	OFF	OFF	OFF	OFF	OFF

System Status At Non-Deployment

Ignition Cycles At Investigation	6902
SIR Warning Lamp Status	OFF
SIR Warning Lamp ON/OFF Time Continuously (seconds)	655350
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	6727
Ignition Cycles At Event	6900
Ignition Cycles Since DTCs Were Last Cleared	255
Driver's Belt Switch Circuit Status	BUCKLED
Diagnostic Trouble Codes at Event, fault number: 1	N/A
Diagnostic Trouble Codes at Event, fault number: 2	N/A
Diagnostic Trouble Codes at Event, fault number: 3	N/A
Diagnostic Trouble Codes at Event, fault number: 4	N/A
Diagnostic Trouble Codes at Event, fault number: 5	N/A
Diagnostic Trouble Codes at Event, fault number: 6	N/A
Diagnostic Trouble Codes at Event, fault number: 7	N/A
Diagnostic Trouble Codes at Event, fault number: 8	N/A
Diagnostic Trouble Codes at Event, fault number: 9	N/A
Maximum SDM Recorded Velocity Change (MPH)	6.59
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	260
Crash Record Locked	No
Deployment Event Recorded in the Non-Deployment Record	No
Multiple Event Data/Vehicle Event Data (Pre-Crash) Associated With This Event	No
Event Recording Complete	Yes
Driver First Stage Deployment Loop Commanded	No
Passenger First Stage Deployment Loop Commanded	No
Driver Second Stage Deployment Loop Commanded	No
Driver 2nd Stage Deployment Loop Commanded for Disposal	No
Passenger Second Stage Deployment Loop Commanded	No
Passenger 2nd Stage Deployment Loop Commanded for Disposal	No
Driver Pretensioner Deployment Loop Commanded (If Equipped)	No
Passenger Pretensioner Deployment Loop Commanded (If Equipped)	No
Driver Side Deployment Loop Commanded (If Equipped)	No
Passenger Side Deployment Loop Commanded (If Equipped)	No
Second Row Left Side Deployment Loop Commanded (If Equipped)	No
Second Row Right Side Deployment Loop Commanded (If Equipped)	No
Driver (Initiator 1) Roof Rail/Head Curtain Loop Commanded (If Equipped)	No
Passenger (Initiator 1) Roof Rail/Head Curtain Loop Commanded (If Equipped)	No
Driver (Initiator 2) Roof Rail/Head Curtain Loop Commanded (If Equipped)	No
Passenger (Initiator 2) Roof Rail/Head Curtain Loop Commanded (If Equipped)	No
Driver (Initiator 3) Roof Rail/Head Curtain Loop Commanded (If Equipped)	No
Passenger (Initiator 3) Roof Rail/Head Curtain Loop Commanded (If Equipped)	No
Driver Knee Deployment Loop Commanded (If Equipped)	No
Passenger Knee Deployment Loop Commanded (If Equipped)	No
Second Row Left Pretensioner Deployment Loop Commanded (If Equipped)	No
Second Row Right Pretensioner Deployment Loop Commanded (If Equipped)	No
Second Row Center Pretensioner Deployment Loop Commanded (If Equipped)	No



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Longitudinal Axis Recorded Velocity Change (MPH)	0.00	0.51	0.51	0.00	0.00	0.00	0.00	-0.51	-0.51	-0.51	-1.02	-1.53	-2.04	-3.06	-3.06
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
SDM Longitudinal Axis Recorded Velocity Change (MPH)	-3.57	-4.08	-4.08	-4.59	-5.10	-5.10	-5.10	-5.10	-5.10	-5.10	-5.10	-5.61	0.51	0.51	0.51



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Lateral Axis Recorded Velocity Change (MPH)	0.00	1.02	0.00	-0.51	-0.51	-0.51	-1.53	-1.53	-2.04	-2.04	-2.04	-1.53	-1.53	-1.53	-1.53
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
SDM Lateral Axis Recorded Velocity Change (MPH)	-1.53	-1.53	-1.02	-1.02	-0.51	-0.51	0.00	0.00	1.02	1.53	1.53	2.55	-0.51	-0.51	-0.51

Hexadecimal Data

Data that the vehicle manufacturer has specified for data retrieval is shown in the hexadecimal data section of the CDR report. The hexadecimal data section of the CDR report may contain data that is not translated by the CDR program. The control module contains additional data that is not retrievable by the CDR system.

```
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$02  00 00 00 00 00 00 00
$03  00 00 00 00 00 00 00
$04  00 00 00 00 00 00 00
$05  00 00 00 00 00 00 00
$06  C5 00 00 00 00 00 00
$0A  00 00 00 00 00 00 00
$0B  00 00 00 00 00 00 00
$0C  00 00 00 00 00 00 00
$0D  00 00 00 00 00 00 00
$0E  00 00 00 00 00 00 00
$0F  00 00 00 00 00 00 00
$10  00 00 00 00 00 00 00
$11  27 FF FF 7D 7C 00 00
$12  FF 00 F0 F0 E0 00 00
$13  C0 00 80 20 20 00 00
$14  C0 00 80 20 20 00 00
$15  01 02 00 00 00 00 00
$16  00 00 00 00 00 00 00
$17  00 00 00 00 00 00 00
$18  02 0A 0A 0A 0A 0A 0A
$19  07 07 00 00 00 00 00
$1A  00 00 00 00 00 00 00
$1B  00 00 00 00 00 00 00
$1C  00 00 00 00 00 00 00
$1D  00 00 00 00 00 00 00
$1E  01 00 00 00 00 00 00
$1F  00 00 00 00 00 00 00
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$22  00 00 00 00 00 00 00
$23  00 00 00 00 00 00 00
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$29  00 00 00 00 00 00 00
$2A  00 87 00 00 00 00 00
$2B  20 21 50 00 00 00 00
$2C  80 80 7F 7F 7F 7E 00
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$34  00 00 00 00 00 00 00
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$36  00 00 00 00 00 00 00
$37  00 00 00 00 00 00 00
$38  00 00 00 00 00 00 00
$39  00 00 00 00 00 00 00
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```
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$3B  00 FF FF 1A 49 00 00
$3C  00 FF 1A F6 02 1A F6
$3D  2F C0 00 00 00 00 00
$40  00 00 00 10 21 00 00
$41  00 00 00 00 00 00 90
$42  1B 21 26 28 2A 00 00
$43  05 AF 05 CD 00 00 00
$44  00 00 06 11 1E 00 00
$45  63 6C 72 77 79 00 00
$46  AC 2F C0 00 00 00 00
$50  00 A5 00 00 00 00 00
$51  00 00 00 00 00 00 00
$52  00 FF FF 1A 47 00 00
$53  FF 1A F4 1A F4 00 00
$54  00 00 00 00 00 00 00
$55  00 00 00 00 00 00 00
$56  00 00 00 00 00 00 00
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$58  00 00 00 00 00 00 00
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$5C  01 FC 02 FC 03 FD 00
$5D  04 FD 06 FD 06 FD 00
$5E  07 FD 08 FD 08 FE 00
$5F  09 FE 0A FF 0A FF 00
$60  0A 00 0A 00 0A 02 00
$61  0A 03 0A 03 0B 05 00
$62  FF FF FF FF FF FF 00
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$64  1A 00 A7 00 00 00 00
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$90  00 00 00 00 00 00 00
$91  00 00 00 00 00 00 00
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$9F  00 00 00 00 00 00 00
$A0  00 00 00 00 00 00 00
$A1  00 00 00 00 00 00 00
$A2  00 00 00 00 00 00 00
$A3  00 00 00 00 00 00 00
$A4  00 00 00 00 00 00 00
$A5  00 00 00 00 00 00 00

$01  41 44 30 30 30 30 58 30 30 30 30 30 30 30 30 30
$02  01
$03  41 5A 30 30 30 30 58 30 30 30 30 30 30 30 30 30
$04  00
$05  41 5A 30 30 30 30 58 30 30 30 30 30 30 30 30 30
$06  00
$07  41 5A 30 30 30 30 58 30 30 30 30 30 30 30 30 30
$08  00
```

```
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$0A  00
$0B  41 5A 30 30 30 30 58 30 30 30 30 30 30 30 30 30
$0C  00
$0D  41 5A 30 30 30 30 58 30 30 30 30 30 30 30 30 30
$0E  00
$0F  00 00 00 00
$22  80 66
$23  FA FA FA FA FA FA FA FA
$24  FA FA FA FA FA FA FA FA
$25  FA FA FA FA FA FA FA FA
$26  FA FA FA FA FA FA FA FA
$40  00 00
$42  56 08 14
$43  00 00 CC 80
$44  56 3E E0 C0 FF FC
$45  00 00 14 14 64 64 64 64
$46  04 64 04 04 64 04 64 04 04 64 00 00
$47  1D 09 08
$B4  41 53 38 30 35 37 4B 52 38 31 36 34 32 32 36 38
$C1  01 8B 67 EF
$C2  01 8B A1 82
$CB  01 8B A1 79
$CC  01 8B A1 79
$DB  41 41
$DC  41 41
```

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